

The documentation and process conversion measures necessary to comply with this revision shall be completed by 24 April 2015.

INCH-POUND

MIL-PRF-19500/74F
24 October 2014
SUPERSEDING
MIL-S-19500/74E
AMENDMENT 4
11 August 1986

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, MEDIUM-POWER,
THROUGH-HOLE MOUNT PACKAGE, TYPES 2N497, 2N498, 2N656, AND 2N657,
QUALITY LEVEL JAN

Inactive for new design after 7 June 1999.

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and [MIL-PRF-19500](#).

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, medium power transistors. One level of product assurance (JAN) is provided for encapsulated devices.

1.2 Package outlines. The device package outlines are as follows: TO-205AA (formerly modified TO-5) (without suffix S, see [1.5.3](#)) or a TO-205AD (formerly modified TO-39) (with suffix S, see [1.5.3](#)) in accordance with [figure 1](#) for all encapsulated device types.

1.3 Maximum ratings. Unless otherwise specified, $T_A = +25^\circ\text{C}$.

Type	P_T (1) $T_A = +25^\circ\text{C}$	P_T (2) $T_C = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	T_{STG}
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>°C</u>
2N497	0.8	4	60	60	8	-65 to +200
2N498	0.8	4	100	100	8	-65 to +200
2N656	0.8	4	60	60	8	-65 to +200
2N657	0.8	4	100	100	8	-65 to +200

(1) Derate linearly 4.6 mW/°C for $T_A > +25^\circ\text{C}$.

(2) Derate linearly 23 mW/°C for $T_C > +25^\circ\text{C}$.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

FSC 5961

1.4 Primary electrical characteristics. Unless otherwise specified, $T_A = +25^\circ\text{C}$.

Limits	h_{FE} $V_{CE} = 10\text{ V dc}$ $I_C = 50\text{ mA dc}$		$h_{FE} (1)$ $V_{CE} = 10\text{ V dc}$ $I_C = 200\text{ mA dc}$		$ h_{FE} $ $V_{CE} = 30\text{ V dc}$ $I_C = 30\text{ mA dc}$ $f = 10\text{ MHz}$	$V_{CE(SAT)} (1)$ $I_C = 200\text{ mA dc}$ $I_B = 40\text{ mA dc}$	$V_{BE} (1)$ $I_C = 40\text{ mA dc}$ $V_{CE} = 10\text{ V dc}$
	2N497 2N498	2N656 2N657	2N497 2N498	2N656 2N657			
Minimum	V dc 10	V dc 20	V dc 12	V dc 30	1.5	V dc ---	V dc ---
Maximum	40	100	36	90	10.0	2.0	2.0

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example, 6.5 for a list of available PINs, and 6.6 for supersession information.

1.5.1 JAN certification mark and quality level. The only quality level designator for encapsulated devices that is applicable for this specification sheet is the base quality level "JAN" that uses no modifiers.

1.5.2 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

1.5.2.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

1.5.2.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "497", "498", "656", and "657".

1.5.3 Suffix symbols. The suffix symbol "S" is used on devices that have a shortened lead length: 0.5 inch (12.7 mm) minimum to .75 inch (19.1 mm) maximum. Devices with standard length leads use no suffix. See figure 1.

1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QML-19500.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-19500 – Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-750](#) – Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <http://quicksearch.dla.mil>.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as specified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see [4.2](#) and [6.3](#)).

3.3 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#).

3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in [MIL-PRF-19500](#) and herein. The device package style is either a modified TO-5 or a modified TO-39 in accordance with [figure 1](#) for all device types.

3.4.1 Lead finish. Unless otherwise specified, lead finish shall be solderable in accordance with [MIL-STD-750](#), [MIL-PRF-19500](#), and herein. Unless otherwise specified (see [6.2](#)), the lead finish shall be gold-plated. Where a choice of lead finish or lead formation is desired, it shall be specified in the acquisition document (see [6.2](#)).

3.4.2 Pin-out. The pin-out of the device shall be as shown on [figure 1](#). Terminal 1 is the emitter, terminal 2 is the base, and terminal 3 is the collector. The collector shall be electrically connected to the case.

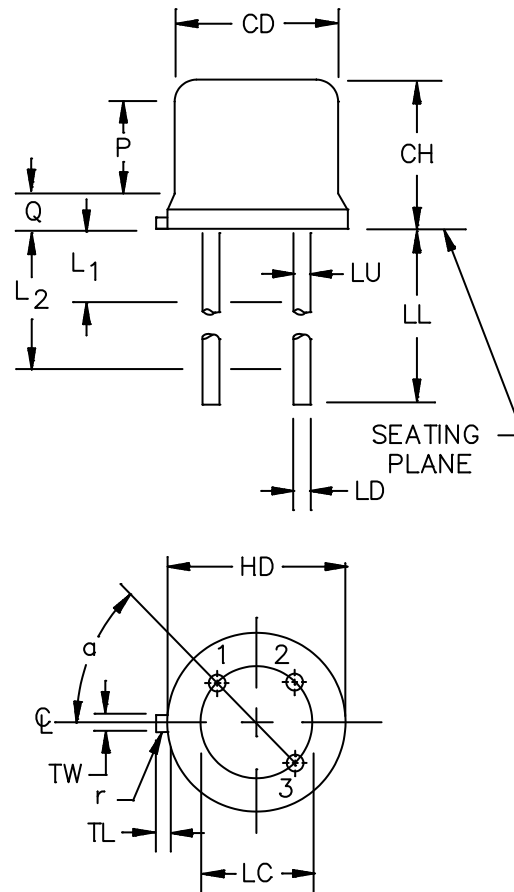
3.4.3 Terminal-lead length. Terminal-lead length(s) other than that specified on [figure 1](#) may be furnished under contract or order (see [6.2](#)) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the Qualified-product status of the device, or applicable JAN marking (see [6.2](#)).

3.5 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics shall be as specified in [1.3](#), [1.4](#), and [table I](#) herein.

3.7 Workmanship. The devices covered by this specification sheet shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	3
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.1414 TP		3.592 TP		4
LD	.016	.021	0.41	0.53	5, 6
LL	See notes 6, 7, and 8				
LU	.016	.019	0.41	0.48	5, 6
L ₁		.050		1.27	5, 6
L ₂	.250		6.35		5, 6
P	.100		2.54		9
Q		.030		0.76	3
TL	.029	.045	0.74	1.14	10, 11
TW	.028	.034	0.71	0.86	10
r		.010		0.25	12
α	45° TP		45° TP		4



NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Lead 1 = emitter, lead 2 = base, lead 3 = collector. The collector shall be internally connected to the case.
3. CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
4. Leads at gauge plane .054 +.001 –.000 inch (1.37 +0.03 –0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by gauging procedure.
5. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in and beyond LL minimum.
6. All three leads. Lead diameter dimension accounts for all lead finishes that can be applied.
7. For the TO-205AA (formerly a modified TO-5) package (PINs without the S suffix), dimension LL is 1.500 inch (38.10 mm) minimum and 1.750 inch (44.45 mm) maximum.
8. For the TO-205AD (formerly a modified TO-39) package (PINs with the S suffix), dimension LL is .500 inch (12.70 mm) minimum and .750 inch (19.05 mm) maximum.
9. Body contour optional within zone defined by HD, CD, and Q.
10. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 (0.28 mm).
11. Dimension TL measured from maximum HD.
12. Dimension r (radius) applies to both inside corners of tab.
13. In accordance with ASME Y14.5M, diameters are equivalent to Φ x symbology.

FIGURE 1. Physical dimensions and configurations of TO-205AA and TO-205AD package.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening. Screening is not applicable for devices compliant to this specification sheet.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500 and table I herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VIB of MIL-PRF-19500 and herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B1	2026	Omit preconditioning.
B3	2046	Nonoperating.
B2	2036	Test condition E.
B6	1031	$T_{stg} = + 200^{\circ}\text{C}$; $t = 340$ hours.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	1031	$T_{stg} = + 200^{\circ}\text{C}$; $t = 340$ hours.
C4	3005	Pre-pulse condition: $T_C = 25^{\circ}\text{C}$, $V_{CE} = 0$, $I_C = 0$. Pulse condition: $V_{CE} = 40$ V dc, $I_C = 0.1$ A dc, $t_p = 60$ second, 1 cycle; $t_r \leq 8$ seconds; $t_f \leq 6$ seconds.
C6	1026	$T_A = 25^{\circ}\text{C}$; $P_T = 0.8$ W; $V_{CE} = 40$ V dc (see 4.3.4).

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table II herein.

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse response measurements. The conditions for pulse response measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Transient thermal impedance. The transient thermal impedance measurements shall be performed in accordance with test method 3131 of MIL-STD-750 using the guidelines in that test method for determining I_M , I_H , t_H , t_{SW} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μ s maximum. See table II, subgroup 4 herein.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Collector to emitter breakdown voltage	3011	Bias condition D, $I_C = 250 \mu A$ dc	$V_{(BR)CEO}$	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Collector to emitter breakdown voltage	3011	Bias condition D, $I_C = 80$ mA dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Collector to base, breakdown voltage	3001	Bias condition D, $I_C = 100 \mu A$ dc.	$V_{(BR)CBO}$	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Emitter to base, breakdown to voltage	3026	Bias condition D, $I_E = 250 \mu A$ dc	$V_{(BR)EBO}$	8.0		V dc
Collector to base, cutoff current	3036	Bias condition D.	I_{CBO}			
2N497, 2N656 2N498, 2N657		$V_{CB} = 50$ V dc $V_{CB} = 80$ V dc			1.0 1.0	μA dc μA dc

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2 – continued</u>						
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 50 \text{ mA dc}$;	h_{FE}			
2N497, 2N498 2N656, 2N657				10 20	40 100	
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 50 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE}			
2N497, 2N498 2N656, 2N657				12 30	36 90	
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 50 \text{ mA dc}$;	h_{FE}			
2N497, 2N498 2N656, 2N657				10 20	40 100	
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 50 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE}			
2N497, 2N498 2N656, 2N657				12 30	36 90	
Collector to emitter voltage (saturated)	3071	$V_{CE} = 4.0 \text{ V dc}$, $I_B = 200 \text{ mA dc}$; pulsed (see 4.5.1).	$V_{CE(sat)}$	---	2.0	V dc
Base to emitter voltage (nonsaturated)	3066	Test condition B; $V_{CE} = 10 \text{ V dc}$ $I_C = 200 \text{ mA dc}$; pulsed (see 4.5.1).	V_{BE}		2.0	V dc
Magnitude of common emitter small-signal, short-circuit forward-current transfer ratio	3306	$V_{CE} = 30 \text{ V dc}$, $I_C = 30 \text{ mA dc}$; $f = 10 \text{ MHz}$	$ h_{FE} $			
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^{\circ}\text{C}$				
Collector to emitter cutoff current	3041	Bias condition A; $V_{BE} = -1.5 \text{ V d}$	I_{CEX}			
2N497, 2N656 2N498, 2N657		$V_{CE} = 60 \text{ V dc}$ $V_{CE} = 100 \text{ V dc}$			300 300	$\mu\text{A dc}$ $\mu\text{A dc}$

TABLE I. Group A inspection – Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3 – continued</u>						
Low temperature operation	3076	T _A = -55°C	h _{FE}	6 15		
Forward-current transfer ratio	3076	V _{CE} = 10 V dc, I _C = 200 mA dc;				
2N497, 2N498 2N656, 2N657						
<u>Subgroup 4</u>						
Collector to emitter breakdown voltage	3011	Bias condition D, I _C = 80 mA dc, pulsed (see 4.5.1)	V _{(BR)CEO}	60 100		V dc V dc
2N497, 2N656 2N498, 2N657						
Forward-current transfer ratio	3076	V _{CE} = 10 V dc, I _C = 50 mA dc, pulsed (see 4.5.1)	h _{FE}	12 30	36 90	
2N497, 2N498 2N656, 2N657						
Collector to emitter voltage (saturated)	3071	V _{CE} = 4.0 V dc, I _B = 200 mA dc, pulsed (see 4.5.1).	V _{CE(sat)}	---	2.0	V dc
Base to emitter voltage (nonsaturated)	3066	Test condition B; V _{CE} = 10 V dc I _C = 200 mA dc; pulsed (see 4.5.1).	V _{BE}		2.0	V dc
Magnitude of common emitter small-signal, short-circuit forward-current transfer ratio	3306	V _{CE} = 30 V dc, I _C = 30 mA dc, f = 10 MHz	h _{FE}			
<u>Subgroups 5 and 6</u>						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.

2/ This test required for the following end-point measurements only:
Group B, subgroups 2 and 3 (JAN).
Group C, subgroup 2 and 6.
Group E, subgroup 1.

TABLE II. Group E inspection (all quality levels) – for qualification and requalification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal	1071		
Fine leak			
Gross leak			
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Steady-state operating life	1026	$T_A = 25^\circ\text{C}$, $P_T = 0.8 \text{ W}$, $V_{CE} = 40 \text{ V dc}$, $t = 340 \text{ hours}$.	
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

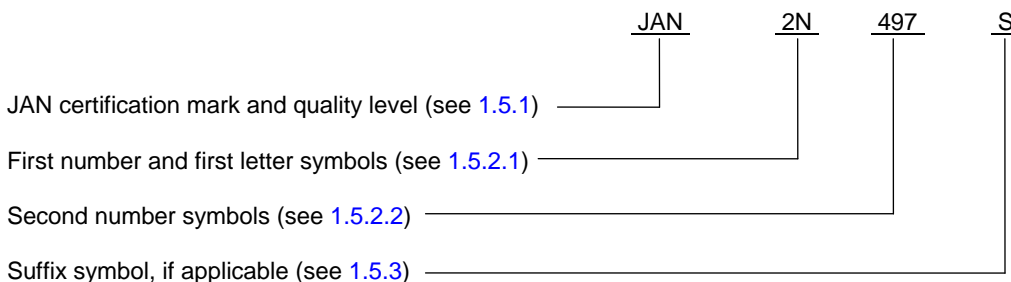
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see [3.4.1](#)).
- d. The complete PIN, see [1.5](#) and 6.4.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



6.5 List of PINs. The following is a list of possible PINs available for devices covered by this specification sheet.

PINs for devices in a TO-205AA (formerly a modified TO-5) (standard lead lengths)	PINs for devices in a TO-205AD (formerly a modified TO-39) (short lead lengths)
JAN2N497	JAN 2N497S
JAN2N498	JAN 2N498S
JAN2N656	JAN 2N656S
JAN 2N657	JAN 2N657S

6.6 Supersession information and superseded PINs.

6.6.1 Lead finish. The original issue of this specification through MIL-S-19500/74D with Amendment 1 (24 August 1964) did not specify a lead finish. Since the release of MIL-S-19500/74E (17 October 1967), the lead finish has been specified as gold-plate.

6.6.2 Lead length. The original issue of this specification through MIL-S-19500/74 with amendment 3 (26 June 1978) did not contain a suffix to designate lead length. MIL-S-19500/74E with amendment 4 (11 August 1986) introduced the "S" suffix option with the associated TO-205AD package. When applicable, PINs covering devices with a shortened lead length now shall include a suffix "S" to designate this package configuration (see 1.2, 1.5, and figure 1.)

6.6.3 Lead material. The original issue of this specification through MIL-S-19500/74D with Amendment 1 (24 August 1964) did not specify a lead material. MIL-S-19500/74E (17 October 1967) specified that the lead material as Kovar. MIL-S-19500/74E with Amendment 2 (20 August 1970) modified the lead material to Kovar or Alloy 52. Because of the performance format of this document, lead material is no longer specified.

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:

Army – CR
Navy – EC
Air Force – 85
DLA – CC

Preparing activity:
DLA – CC

(Project 5961-2014-001)

Review activities:

Army – AR, MI
Navy – AS, CG, MC, SH
Air Force – 19, 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.